DOCUMENT RESUME

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ABSTRACT

This self-paced student training module on measuring, layout, and leveling tools is one of a number of modules developed for Pre-apprenticeship Phase 1 Training. Purpose of the module is to enable students to identify, explain, and demonstrate correct procedures for the use and care of measuring tools, gauges, squares, and levels. The module may contain some or all of the following: a cover sheet listing module title, goal, and performance indicator; study guide/checklist with directions for module completion; introduction; information sheets providing information and graphics covering the module topic(s); self-assessment; self-assessment answers; post assessment; and post-assessment answers. (YLB)

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ED217278

INDIVIDUALIZED LEARNING SYSTEMS

PRE-APPRENTICESHIP PHASE 1 TRAINING

MEASURING, LAYOUT AND LEVELING TOOLS

CE032914

Goal:

At the completion of this module, students will be able to identify, explain and demonstrate correct procedures for the use and care of measuring tools, gauges, squares and levels.

Performance Indicators:

The student will successfully complete a Self Assessment exam, and either an Assignment page or a Post Assessment exam.

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Study Guide

For successful completion of this module, complete the steps in the order listed below, checking each one off as you complete it.

1. ____ Read the Goal and Performance Indicators on the cover of this module to determine what you will be expected to gain. Read the Introduction to discover this module's importance to you and your trade.

2. ____ Study the Information section of the module to acquire the knowledge necessary to answer the exam questions which follow.

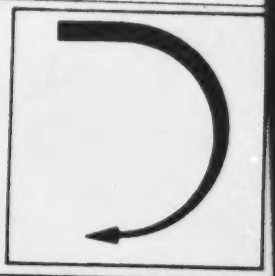
3. ____ Complete the Self Assessment exam, referring to the Information section or asking your instructor where help is needed. It is recommended you score well on this exam before proceeding.

4. ____ Complete the Post Assessment exam, and turn your answer sheets in to your instructor for grading,

or

complete the Assignment page as instructed. It is recommended that you score at least 90% on the Post Assessment or satisfy your instructor by demonstrating thorough and complete knowledge of the subject before going on to the next module.

Introduction



A thorough knowledge of the basic tools and techniques employed for measurement, layout and leveling is of primary importance to every skilled worker. In almost every phase of every job in the construction trades, such tools are needed for establishing and checking sizes and dimensions, lines, and angles, and for ensuring that lines and surfaces are level or plumb.

Each trade has its own measuring problems and methods of solving them. The tools described in this topic are in common use in all the construction trades.

Information

ANGULAR MEASUREMENT TOOLS

The measurement and layout of angles can be done with a common protractor if great accuracy is not required. (See Fig. E-1). More suitable tools--the combination square with a protractor head or the carpenter's steel square, for example--can be employed when the job calls for more accurate measurement and layout of angles. Regardless of the tools or methods used, however, the mechanic will find that a basic knowledge of the geometry of angles will be needed for all work of this kind.

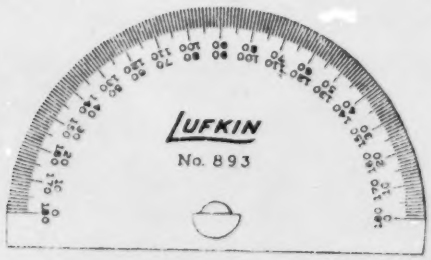


Fig. E-1. Protractor

An angle is formed by two straight lines meeting at a point. If the lines cross (intersect), four angles will be formed around the point of intersection. If the crossing lines are perpendicular (square) to each other, four right angles (square-cornered angles) will be formed. Each right angle is divisible into 90 equal parts, called degrees, which are indicated by the symbol (^{o}). The four right angles added together thus equal 360^{o}, which is also the angular measurement around the circumference of a circle. Each degree is divisible into 60 equal parts called seconds ("). Half of a right angles is 45^{o}; a third 30^{o}; and two thirds, 60^{o}. A 45^{o} angle is often called a miter angle; this is the angle employed for each of the joining ends of the pieces making up a rectangular picture frame.

MEASURING TAPES AND RULES

Measuring tapes and rules commonly used include steel tapes, pocket or "push-pull" rules, and spring-joint ("zigzag") rules. Tapes and rules are available with a

variety of scale markings, including English measure, metric measure, engineers' measure, or some combination of these measures.

STEEL TAPES

A measuring tape consists of a flexible, a graduated tape rolled on a drum and enclosed in a case, with a handle or a spring mechanism for rewinding. Tapes 50 to 200 ft. in length are manufactured for measuring long distances. A cloth tape may be used for rough measuring, but for accurate work the steel tape is preferred. The ring at the end of the tape is provided so that the tape end may be slipped over a nail, and a hook may be included on the ring to permit anchoring the tape at a corner; these features permit an unassisted worker to use the tape for making long measurements. On some tapes, the measurement begins at the outside edge of the ring; on others, a blank space precedes the zero point.

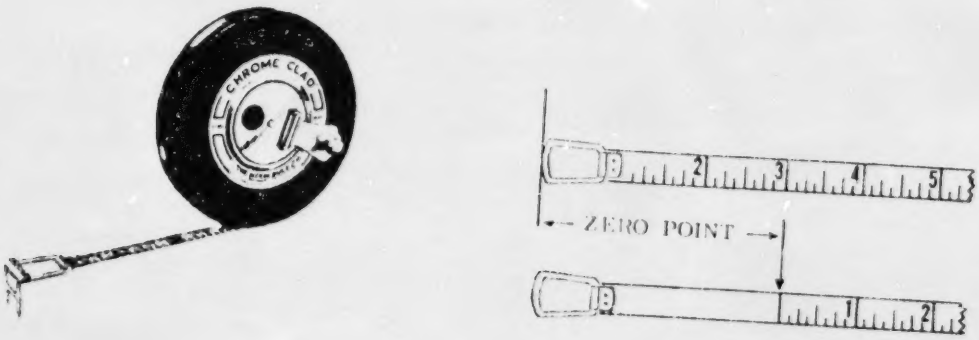


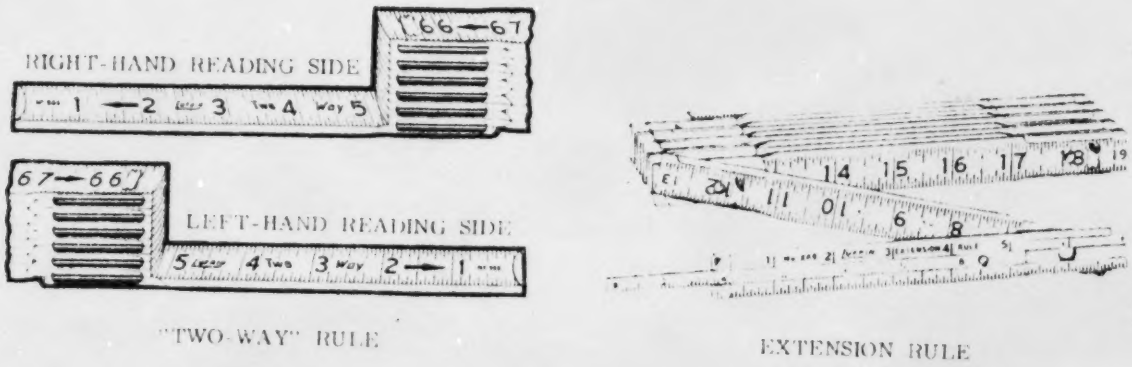
Fig. E-2

A steel tape is a precision instrument. It must be handled carefully and kept clean and dry. The tape should be pulled straight out of the case--never bent back against the opening. The extended tape should not be twisted, bent, or stepped on. Steel tapes should periodically be wiped with a lightly oiled rag; this precaution is especially important when the tape is being used during damp weather.

SPRING-JOINT ("ZIGZAG") RULES

The spring-joint of "Zigzag" rule is a pocket folding rule whose 6-in. sections are connected by means of spring-loaded, locking swivel joints. The sections are unfolded, one at a time, until as much of the rule is extended as is needed for the particular measuring job. Rules of this type are made of wood or metal and are 6 ft. or 8 ft. long when fully extended. Like tapes, they are available in a wide

variety of scale markings. The common zigzag rule is marked on both sides, each side having figures reading from left to right. The "two-way" rule has figures reading from left to right on one side and from right to left on the other. The extension-type rule has a graduated metal slide fitted into one end for convenience in making inside measurements or measuring the depths of holes. (See Fig. E- .)



"TWO-WAY" RULE

EXTENSION RULE

Fig. E-3

LAYOUT TOOLS

A variety of common and special-purpose tools are used in the layout of a building. These tools include the ruler or straightedge; the steel square; the dry-wall T-square; the try-and-miter square; the combination square; the T-bevel; the wing divider; the scriber; and the cotton or nylon line.

RULER OR STRAIGHTEDGE

Any straight-edged tool, such as a ruler or a steel square, may be used in marking straight lines, provided it is longer than the distance between the two points to be connected. A tool made specifically for this purpose is usually called a straightedge. Straightedges are often made on the job of seasoned, warp-resistant wood. They may be beveled on one edge or both, and their edges are sometimes graduated so that they can be used for measuring. The builder's straightedge, which is used in conjunction with a spirit level, will be described later in this topic.

STEEL SQUARE

The steel square (carpenter's framing square) is accurately machined to a right (90^{0}) angle from a single piece of metal. The longer arm of the tool is called the body or the blade; it is usually 24 in. long. The shorter arm, called the tongue, is usually 16 in. long. (See Fig. E-4.)

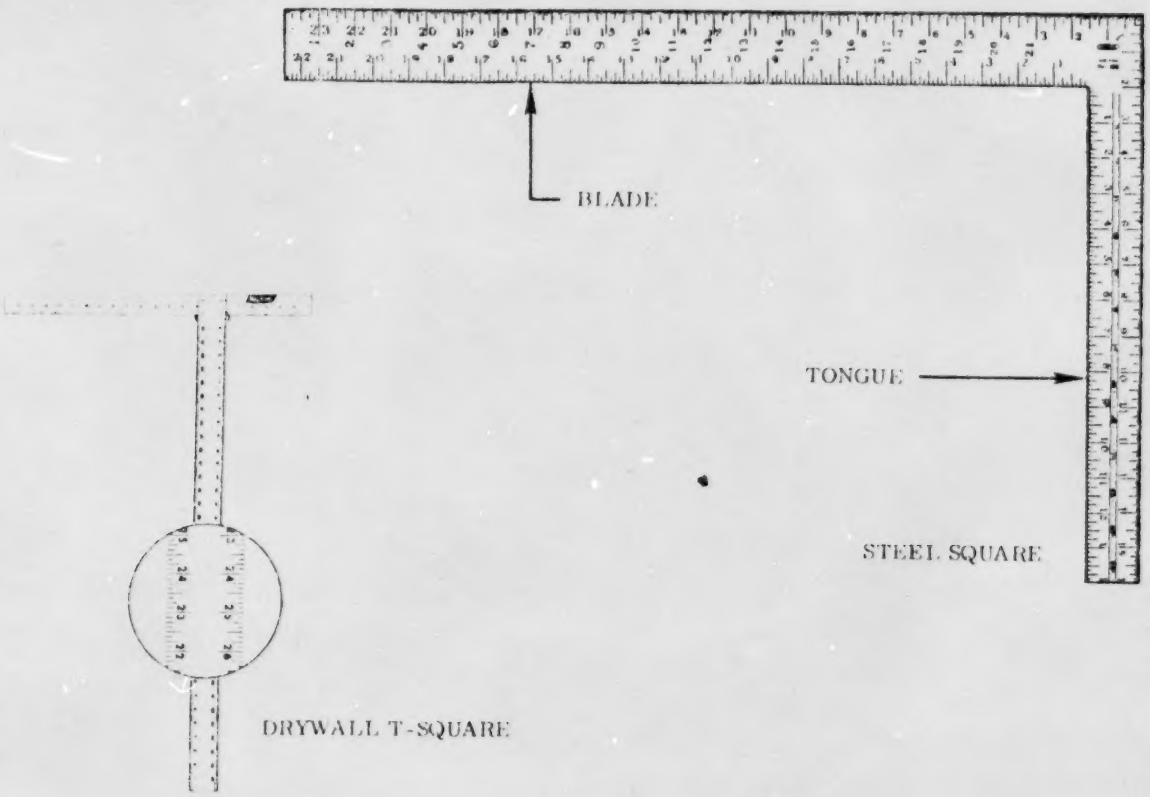


Fig. E-4

The steel square is a versatile measurement tool whose uses go far beyond the mere testing of a piece of material for "squareness." The square has graduations in eighths, sixteenths, twelfths, tenths, and hundredths of an inch along the inside and outside edges of the tongue and the blade. Various measurement scales and tables included on both sides (the face and the back) of the tool simplify the calculations for laying out rafters, spacing studs and joists, and laying all angles.

DRYWALL T-SQUARES

The drywall T-square, which is a variation of the framing square, is used principally for marking wallboard, the blade of the tool lies flat against the material and square with its edge, permitting easy and accurate marking.

TRY-AND-MITER SQUARE

The try-and-miter square is designed for laying out and checking 90^{o} and 45^{o} angles. The tool consists of a single, graduated blade, 6 to 10 in. long, joined at a right angle to a wood or metal handle 4 to 6 in. long. The handle is beveled 45^{o} where

it joins the blade. (See Fig. E-5.) A similar tool without the miter (45°) angle is called a try square.

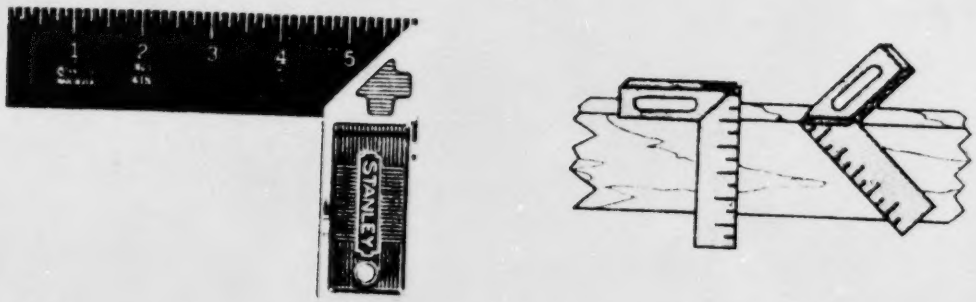


Fig. E-5 Try and miter square

COMBINATION SQUARE

The combination square consists of a graduated blade and a removable head that may be clamped at any desired point along the blade. The blade may be used alone as a straightedge or ruler. The head, when attached, forms a 90° angle with the blade on one side and a 45° angle on the other. A spirit level and a removable scriber are usually included in the head. The combination square is a versatile tool that can be used as an inside or outside try-and-miter square and as a depth or marking gauge. When the tool is fitted with a protractor head instead of the regular square head, it can be used for laying out or checking angles within the range of 0° to 180°. (See Fig. E-9.)

Fig. E-9. Combination squares

T-BEVEL

The T-Bevel is similar to a try square, except that the angle of the blade with respect to the handle is adjustable. Angles up to 180° can be laid out with this tool. When the blade has been set to the desired angle, it is secured with a locking device on the handle. There are no graduations on the blade or on the handle; a protractor is needed for setting the blade unless the T-bevel is being used to transfer an angle from one piece of work to another. (See Fig. E-10.)

Fig. E-10. T-bevel

WING DIVIDERS AND SCRIBERS

Circles and circular lines (arcs) are most easily laid out with a compass or a wing divider if the radius of the circle is not too large. Wing dividers and compasses are similar in appearance and use, except that a compass always includes a pencil as one of its legs, and it may not include a thumb screw or other locking device to hold the chosen setting of the legs. Both legs of a divider are solid metal ground to a point. Some dividers are made so that a pencil can be substituted for one of the metal points to increase the usefulness of the tool in the layout work. (See Fig. E-11.) The common scriber looks like a sturdily constructed compass with a wing nut at the joint to hold the chosen setting. It is very useful for such jobs as transferring an irregular line from a masonry wall to a mating wooden member to achieve a close fit between the wood and the uneven masonry surface. The term "scriber" is also used to describe any sharp-pointed tool used for marking.

Fig. E-11. Divider with interchangeable points

LINES

A line or cord of cotton or nylon, stretched taut from one layout point to another, is commonly used in construction work to indicate or mark a straight line. The "chalk line" commonly employed for marking temporary straight lines, say for laying out an excavation, consists of a taut chalk-loaded cord which, when snapped over the surface to be marked, deposits chalk in a straight line on the surface. The most useful version of the chalk line is the self-chalking line, which is wound on a drum within a case, much like the steel tape described earlier in this module. The line passes through a well of chalk dust as it is unwound from the case.

In using a chalk line, you should first attach one end of the string to a nail close to the work surface at one layout point. You should then stretch the line straight across to a nail at the other layout point, chalking as you unwind it (unless, of course, the line is self-chalking). When the chalked line has been drawn taut and secured between the layout points, you should grasp it at the mid-point with your thumb and first finger, pull it straight up as though you were drawing a bow, then release it with a snap against the surface. The resulting chalk deposit is easily removed after it has served its purpose as a temporary layout line.

LEVELING TOOLS

Checking lines and surfaces for level and plumb is a common requirement in technical occupations. A level line or surface is horizontal--parallel to the plane of the horizon. A plumb line is vertical--at right angles (perpendicular) to the plane of the horizon. The devices most often used in checking for level and plumb include spirit levels, straightedges, and plum lines and bobs.

SPIRIT LEVEL

A spirit level consists of one or more slightly curved glass tubes or vials, each partly filled with ether or alcohol, accurately mounted in a rectangular wood or metal frame. (See Fig. E-12.) The small air bubble remaining in each vial moves to the exact center when the long axis of the vial is perfectly horizontal; the bubble then lies entirely within two marks engraved on the vial. In use, the spirit level is set squarely on the surface to be tested, as in Fig. E-13. If the bubble goes to the right or the left of the center lines, the surface is not level; one end of the work must be raised or lowered until the bubble is centered.

Fig. E-12. Spirit level

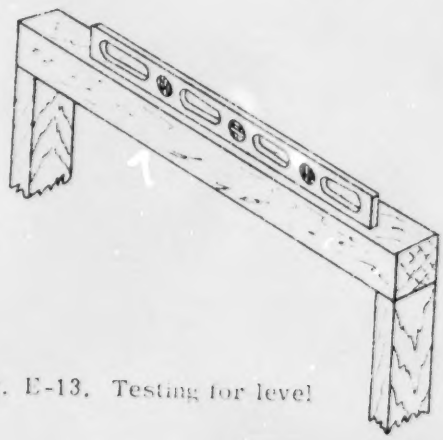


Fig. E-13. Testing for level

A spirit level usually includes vertical as well as horizontal vials so that the instrument can be used for checking plumb as well as level. In some spirit levels, a vial may be set in a rotatable housing so that it can be used for both horizontal and vertical checking. In still others, an additional vial may be set in the frame at a 45^{o} angle for checking miter angles. The most popular hand levels are those made of metal, the light-alloy types being preferred. The spirit levels generally used in the construction industry range in length from 12 to 28 in. and have at least six tubes.

A spirit level must be handled with care; its accuracy may be impaired if it is dropped or struck. In selecting a level for use, the worker should ensure that the sides of the tool are true and straight, and should check the accuracy of the vials by taking test readings on surfaces known to be level and plumb.

BUILDER'S STRAIGHTEDGE

When the level of a long or large surface must be tested, a builder's straightedge may be used to increase the effective length of the spirit level. (See E-14.) A builder's straightedge is generally made of specially selected, straight, smooth wood and is from 6 to 8 ft. long and about 5 in. wide. The top edge of the straightedge is usually tapered off on both sides of a center section that is about 30 in. long and parallel with the bottom edge. This parallel center section serves as the base for the spirit level.

Fig. E-14. Builder's straightedge

PLUMB BOB

A test for plumb can be made with a spirit level held squarely against the vertical surface to be tested, but an alternate method employing a plumb bob and line is often employed for this purpose. A plumb bob is a pointed iron or steel weight with provision for axial attachment of a line at the end opposite the point. (See Fig. E-15.) In testing for plumb with a plumb bob and line, the line is attached to a temporary projection on the structure to be checked as shown in Fig. E-16.

The suspended bob thus hangs free and holds the line perfectly vertical. The structure is plumb when all its vertical surfaces are made parallel with the suspended line. Braces are then added as shown in the figure to keep the structure plumb.

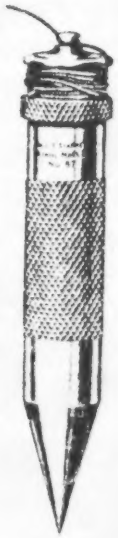


Fig. E-15. Plumb bob

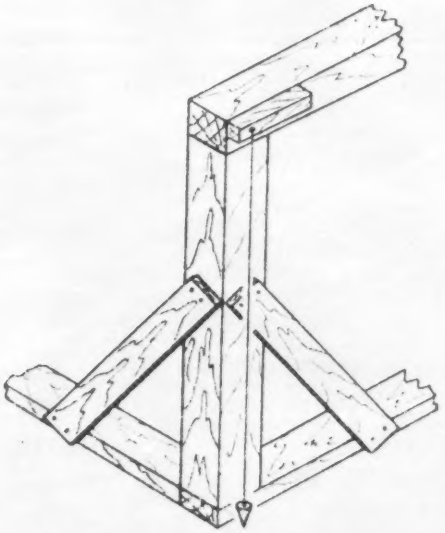


Fig. E-16. Testing for and establishing plumb

MICROMETER

The micrometer caliper consists of a highly accurate ground screw or spindle which is rotated in a fixed nut, thus opening or closing the distance between two measuring faces on the ends of anvil and spindle. A piece of work is measured by placing it between the anvil and spindle faces and rotating the spindle by means of the thimble until anvil and spindle both contact the work. The desired work dimension is then found from the micrometer reading indicated by the graduations on the sleeve and thimble.

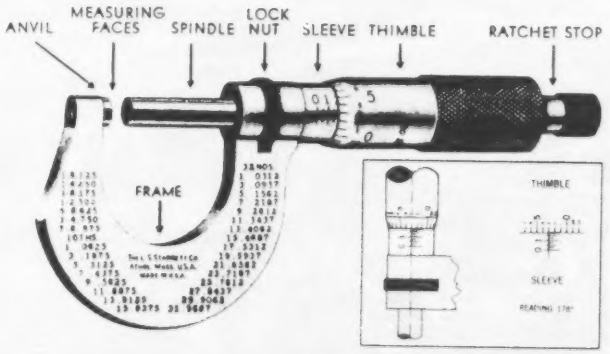


Fig. E-17

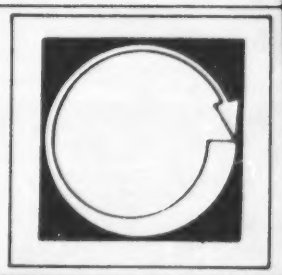
Assignment

You are required to complete either the Assignment page or the Post Assessment before receiving credit for completing this module. The assignment consists of successfully completing one of the following. Please complete the Self Assessment before doing the Assignment or taking the Post Assessment.

1. Demonstrate to your instructor your knoweldge of the tools covered in this module by identifying, naming and showing the proper use of all of the following: protractor, steel tape, steel square, try-and-miter square, combination square, T-bevel, divided, spirit level, micrometer.

2. Your instructor will assign you a problem or project in which you must use at least five of the tools listed above.

Self Assessment



After you have studied the material in this section, complete the exercise by writing in the word that belongs in each space.

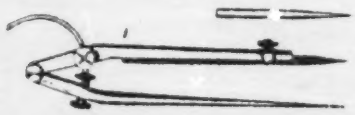
1. A protractor is a device for making _____ measurements.
2. One-sixtieth of an angular degree is called a(n) _____.
3. One-third of a right angle is equal to _____ degrees.
4. Spring-joint rules, sometimes called _____ rules, are commonly _____ or _____ feet long when fully extended.
5. A swivel-joint rule that has a graduated slide fitted into its first folding section is called a(n) _____ rule.
6. A straightedge may be used in laying out a straight line between two points provided it is _____ than the distance between the two points.
7. The longer arm of a steel square is called the _____; the shorter arm is called the _____.
8. A try-and-miter square can be used as a _____ gauge.
9. A combination square can be used as a _____ gauge.
10. A wing divider is similar in appearance and use to a _____.
11. A miter angle is a _____ degree angle.
12. A plumb line is at a _____ degree angle to a level line.
13. A spirit level can be used for checking _____ as well as level surfaces.
14. A line weighted with a plumb bob hangs _____ to the plane of the horizon.
15. An instrument used to measure very fine thicknesses or measure exactly is called a(n) _____.

SELF ASSESSMENT ANSWER SHEET

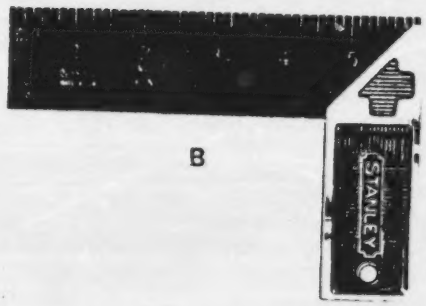
1. angle
2. minute
3. 30
4. zig-zag, six, eight
5. extension
6. longer
7. body, tongue
8. miter
9. depth or marking
10. scriber
11. 45 degree
12. 90
13. plumb
14. perpendicular
15. micrometer

Post Assessment

A group of tools for measurement, layout, and leveling is shown on this page. In each space in the numbered column below, write the letter of the illustrated tool that matches the tool named in the column.



A



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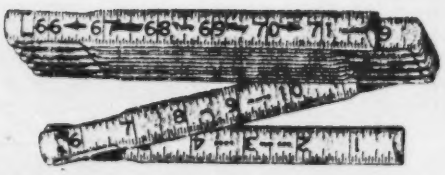

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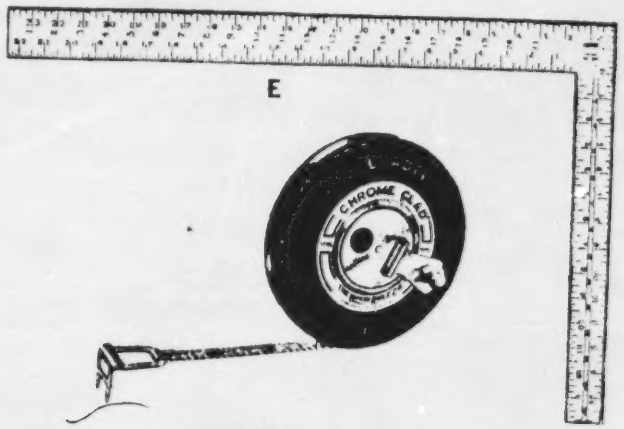

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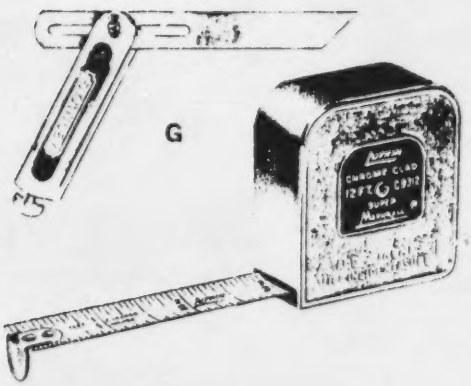


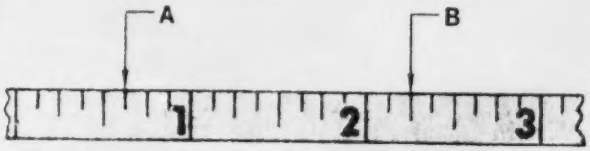
G

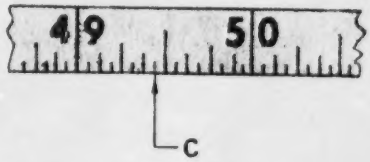
H

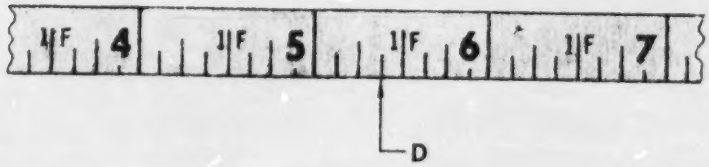
1. ____ push-pull rule
2. ____ zigzag rule
3. ____ framing square
4. ____ miter square
5. ____ T-bevel
6. ____ divider

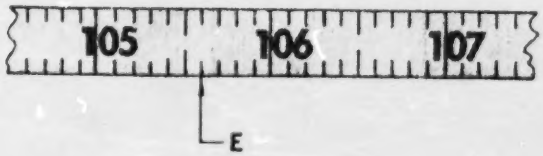
I

Certain measurements are indicated by arrows on the tapes shown on this page. In the space following each measurement point listed in the column at the left below, write the correct measurement chosen from the column at the right.









7. Point A _____

8. Point B _____

9. Point C _____

10. Point D _____

11. Point E _____

1'5-3/8"

2-1/8"

105.6"

4'9-7/16"

5/8"

2-1/4"

10'5"

49-7/16"

Listed below each numbered item are four possible answers or completing phrases. Decide which of the four is correct, or most nearly correct; then write the corresponding letter in the blank space to the left of that item.

12. ____ A level surface is one that is:

a. a plane
b. parallel to the ground
c. perpendicular to the plane of the horizon
d. at right angles to a plumb line

13. ____ Which one of the following measuring devices would be most suitable for the quick testing of the 45^{0} cuts required for the fabrication of a picture frame?

a. extension rule
b. try and miter square
c. protractor
d. T-bevel

14. ____ Which one of the following devices would be least suitable for measuring the circumference of a post?

a. steel tape
b. push-pull rule
c. spring-joint rule
d. cloth tape

15. ____ When a joint is "square," it has:

a. four corners
b. an angle of 90^{0}
c. smooth edges
d. an angle of 100^{0}

16. ____ Which of the following devices would not be suitable for laying out a miter angle?

a. T-bevel
b. combination square
c. straightedge
d. steel square

17. ____ Arcs can be laid out with the aid of a:

a. wing divider
b. plumb bob
c. try and miter square
d. spirit level

18. ____ A chalk line is useful for:

a. drawing a permanent dividing line
b. testing a level edge
c. laying out a straight line
d. marking a pattern

19. ___ A "zigzag" rule is usually how long when fully extended?

a. 4" to 6"
b. 6' to 8'
c. 50'
d. 6 yds.

20. ___ The most useful device for measuring the inside dimensions of a roughed-in window opening would be a:

a. push-pull rule
b. cloth tape
c. straightedge
d. steel tape